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STANDARD FOR WATER, WASTEWATER, STORM DRAIN INFRASTRUCTURE, Levels I and II

Version 1.0

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The Office of Geographic and Environmental Information (MassGIS)
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INTRODUCTION

Information about water, wastewater, and storm drain infrastructure (hereafter "pipe data" or "pipe infrastructure") is useful in many contexts including:

- Providing clean drinking water,
- Removing and treating wastewater,
- Removing storm water.
- Planning for development,
- Safeguarding public health, and
- Protecting environmental resources.

Mapping areas served by this type of infrastructure exists is also useful, particularly in managing environmental impacts and in developing regional land use plans.

While still not the norm, municipal information about pipes is increasingly being incorporated into GIS (geographic information system) databases at the local level. The number of communities using GIS tools to manage infrastructure is increasing because of:

- General trends in using computer-based tools in the organizations that manage and maintain pipe data,
- Federal requirements for reporting on point and non-point sources of water pollution,
- Changes in government financial accounting standards ("GASB34") which require communities to better account for physical assets

Similarly, regional and state level organizations are increasingly interested in using GIS to collect data about pipes and service territories. This interest includes:

- Identifying where development can occur without additional infrastructure.
- Identifying resources that should be targeted for protection (e.g., potential drinking water supplies, sensitive biological resources) because the availability of pipe infrastructure might encourage development., and
- Identifying exports and imports of water from watershed with potential impacts on surface and ground water systems.

Given that state and regional organizations are increasingly building GIS databases of pipe data and/or service territories, MassGIS has solicited input from its GIS partners and is disseminating this standard, which is designed for data managed at a regional scale including:

1) Linear representations of pipe data.
2) Related point features typically found in this kind of infrastructure (e.g., manholes, fire hydrants, catch basins, pump stations, water tanks, etc.)
3) A polygon or polygons representing service area territories for each type of service.

A later release of this standard will be more relevant to the needs of municipalities using GIS to directly manage pipes and associated infrastructure.

There are numerous benefits associated with having standards for the format, quality, and documentation of GIS data for pipe data. For example, if digital pipe data from multiple communities are to be used together, it must all be developed according to the same digital file standard, or at a minimum, it must have common, well-defined and compatible data elements. Without a standard, making digital files from multiple communities compatible requires a prohibitive amount of work. Standardization also makes it easier and more efficient to use these files for developing end-user applications.

Goals

This standard has five goals:

1. Provide a flexible, yet consistent, specification for compiling the locations of pipes in geographic information systems (GIS).
2. Providing a standard for compiling the boundaries of service territories for pipe infrastructure.
3. Provide standardized attributes for pipe data in GIS databases
4. Make it possible to merge digital mapping of this type of municipal infrastructure from more than one community for regional mapping and analysis. This would most likely be achieved by developing “cross-walks” or “translations” between attributes in data sources and the attributes of this standard.
5. Help prevent those in the process of creating these data sets from “re-inventing the wheel” by providing a standard based on generally accepted design requirements on which to base their own database designs

Compliance with Level I of this standard (both for compilation and for attributes) should be the minimum required by any local, regional, or state agency that creates or contracts for the creation of a digital version of existing water, wastewater, or storm drain infrastructure maps, or more generally, as part of any contract for management and consulting services relative to pipe infrastructure. Requiring compliance with this standard will not usually be burdensome, as digital representations of this type of infrastructure developed by engineering and consulting

firms would typically comply with most, if not all, of the Level I and probably the Level II requirements as a matter of good professional practice. In the case of existing data, compliance with this standard may involve a "cross walk" between features and attributes in their "native" form and the way those features and attributes are presented in this standard.

Overview

Levels I and II of this standard are directed at those interested in developing data sets for general planning purposes, both local and regional. Level III will be targeted towards users concerned with day-to-day operations, typically in a Department of Public Works or similar municipal department. Because the standards for feature compilation and for feature attributes are independent, it is expected that pipe data sets might comply with a lower level of the compilation and a higher level of the attribute requirements, or vice-versa.

Existing standards and database designs consulted in preparing this document include ESRI's published "Water Utilities" data model and database designs provided by several consultants[1].

Authority

As the Commonwealth's Office of Geographic and Environmental Information, MassGIS has the legislatively assigned authority and mandate to "set standards for the acquisition and management of geographical and environmental data by any agency, authority or other political subdivision of the Commonwealth" (Ch. 21A, 4B, MGL). Use of this standard may be required when state funding is involved in a project. Otherwise, while it is good professional practice to use existing standards, use of this standard is voluntary.

Development Process

MassGIS is issuing this standard after a collaborative process involving a number of interested parties. In fact, the original suggestion to create a standard came from one of the regional planning agencies (RPAs). Many of the RPAs have been designated as Regional GIS Service Centers by MassGIS and are frequent collaborators with MassGIS on data development and other GIS related activities.

MassGIS staff and GIS staff at the RPAs initially identified potential stakeholders in this standard. MassGIS staff subsequently organized a meeting of those stakeholders to discuss prospective content of such a standard. The representatives of each organization contributed their perspective on content. One outcome from this initial meeting was agreement that any standard should account for current interests (largely oriented towards regional planning) in pipe data, while also anticipating future development of additional larger-scale pipe

[1] Thanks to Applied Geographics, Camp Dresser and McKee, and Tighe and Bond.

data with greater detail at the municipal level. While some communities have developed larger-scale representation of their infrastructure as part of their GIS databases, many communities have not. As noted above, a future version of this standard will include a "Level III" directed at the needs of municipalities.

The second outcome was agreement that several "levels" within the standard made sense. Level I of this standard is the most general and, once developed, Level III will be the most detailed. With different levels in the standard, different kinds of organizations can comply with the standard in the fashion most appropriate to their needs, while developing data sets that have at least a minimum level of compatibility.

Those attending the initial meeting reviewed an initial draft of this standard. Subsequent drafts of the standard were reviewed by a larger group of individuals from interested organizations. Appendix C contains a full listing of those who have commented on or otherwise contributed to developing this standard.

Issues in Modeling Infrastructure in GIS Databases

There are different ways to model natural or cultural entities or phenomena in GIS databases; pipe data are no exception. Modeling approaches change as computer technology evolves. These changes are in turn reflected in the specifics of how GIS software vendors model data in their products For example, some communities have already built these kinds of GIS databases using ESRI's[2] Arc/Node topology model. While that model converts readily to the ESRI "shape file" format, doing so requires changing how the components of pipe data are modeled. More recently, an "object oriented" approach has enabled GIS database developers to construct models that more closely match the "real world" way in which organizations manage information about pipe data.

One of the challenges in creating this standard is specifying the content in a manner that is on the one hand comprehensive and appropriately detailed, and on the other hand sufficiently generic so that the various elements of the standard correspond to elements in different GIS database models.

Finally, another issue that affects how pipe data are modeled in a GIS database is the support of network modeling software (e.g., hydraulic models for water systems). For example, excluding lateral lines (e.g., those supplying a fire hydrant) from the pipe data might be necessary so as to simplify the network by reducing the number of physical pipe segments in a model. As work on this standard proceeds, one assumption is that the network structure requirements of modeling software will not necessarily be satisfied, even at level III.

[2] ESRI-based approaches to data modeling are mentioned explicitly because that is the dominant GIS software in Massachusetts at the time this standard was developed; this reference does not constitute an endorsement of those approaches to this issue. Other GIS software products (e.g., MapInfo, Intergraph) have their own equally valid approaches to modeling spatial data.

GENERAL REQUIREMENTS

File Naming Convention for Town-by-town Data

This naming convention only applies to data files being delivered to a state or regional agency that provided funding for developing or enhancing the files on a town by town basis. When this is the case, the following naming conventions apply:

For pipe features:

Water_<townID>
Sewer_<townID>
Drain_<townID>

For point features:

Waterpt_<townID>
Sewerpt_<townID>
Drainpt_<townID>

Exceptions may be allowed, but only if approved by the funding agency. Note that within a town there may be different suppliers and independent pipe networks. Such differences will be tracked in the attribution of the pipes and other infrastructure.

Service Territory Boundary Compilation

Compiling service territory boundaries involves creating polygons representing areas in which service is available through a specific provider. Table 1, below, indicates requirements and recommendations for compiling these boundaries at each level of the standard.

Table 1: Service territory compilation requirements and recommendations (see discussion following table).

	Buffer Arcs Representing Infrastructure	Augment with geocoded service and/or billing locations	Augment with Thematically Mapped Parcels (Level I parcels or better)	Augment based on expert input from service providers; other data sets
Level I	Required*	NA	NA	Recommended
Level II	Required*	Recommended	Recommended	Recommended
Level III	Required*	Required*	Required*	Required*

* Note that the requirements provide a minimum level of quality and consistency in how these territories are mapped; all the requirements are overridden if an alternative approach exists that will produce a comparable or more spatially accurate representation of the service territory. For example, as a trivial case, if an entire community is built out and has wastewater service, then the service territory is the town boundary.

Buffering Arcs

The service area can be developed by buffering the pipe network to a presumed maximum distance (sewer and storm drain pipes to 45m or 150 ft. and water pipes to 60m or 200 ft.) for a service line. Service area boundaries can then be developed based on the guide provided by these buffers. Interior "doughnut holes" in the resulting buffer smaller than one hectare (2.5 ac.) would be dissolved.

Augment by Geocoding Service/Billing Addresses

Service and billing records for sewer/water service are available from cities and towns. Geocoding service addresses may have a low match rate because such addresses are often poor quality. However, those that do geocode will provide additional information about service locations. Billing addresses are better quality than service addresses because of minimum requirements for bills to be delivered correctly. If billing addresses can be limited to those where the billing and service address are the same, geocoding those addresses will also be useful in refining service territories. Otherwise there may errors caused by cases where owners of property inside a service territory reside, and receive bills, at addresses outside the territory.

Thematically Map Parcels

Some assessor's databases identify parcels that receive water and sewer service. If the community assessor maps are in digital form and the quality of the boundary compilation is at least that of Level 1 in the MassGIS Digital Parcel Standard, then shading parcels based on the presence of sewer service may be a useful assist in identifying where there is service. For very large parcels with mixed land use, some limit on the portion of that parcel may be needed in order to accurately portray the service territory. Otherwise, large parcels that have a house close to the road, with the remainder of the parcel forested, may artificially expand the service territory's limits.

Expert Input and Other Data Sets

Working with system maps and a person familiar with the service territory can be a worthwhile approach to delineating service territories on a street-by-street basis. Service providers will likely have individuals very familiar with service territory limits. Other data sets (e.g., topography, surface water) may be helpful in compiling service territory boundaries. Both these sources can be useful in

determining service territory boundaries and should be used where available and relevant.

COMPILATION REQUIREMENTS FOR POINT AND LINE FEATURES

Under this version of the standard, there are two possible levels of spatial accuracy and completeness for compiling map features and associated infrastructure represented as point and line features. Level I is the less stringent and also, generally, the less useful. It is entirely possible and reasonable that a community might achieve compliance with a lower level of the compilation requirements and a higher level of the attribute requirements.

Below, compilation requirements for each level are presented. These are followed by attribute requirements.

Level I Compilation Requirements

Level I compliant data sets provide a rough approximation, suitable for regional or local general planning purposes, of where pipe infrastructure is located; data complying with this level would not typically be displayed with other more accurate spatial data except as necessary to give a general idea of:

- Approximately what parts of a community are serviced ("the town center has service")
- The location of areas serviced relative to other significant areas of the community ("west and north of the center of town"; "north of Lake such and such")
- The approximate linear distance of the pipe network.

Developing data for this level of the standard presumes that either the source records are poor quality (e.g., a CAD file that is a schematic rather than a map thus rendering geo-referencing difficult) or that there is limited time for the data work, or both. The compilation requirements at this level can be summarized as "do the best you can to achieve minimal geo-referencing of the pipe data" given source records and available time.

Requirements at Level I are:

- Compilation Base Map – Geo-referencing points are developed based on locations (typically street intersections) identified on an orthophoto base map (e.g, 2001 color orthophotos or a successor available through MassGIS), on a geo-referenced parcel map, or on the MassHighway road network.
- The pipe network for each service type is roughly geo-referenced such that it at least draws inside of the city or town's boundaries and approximately in the correct part of the community.
- Point features (e.g., fire hydrants, man holes, catch basins) typical of pipe data may or may not be depicted.

- Massachusetts State Plane Coordinate System, mainland zone (FIPS 2001 - except on the islands where Island Zone shall be used) with a horizontal datum of NAD83

Level II Compilation Requirements

Data developed for this level of the standard are still intended for supporting regional planning needs. However, the spatial accuracy of the arcs representing the pipe networks will be higher such that the data set can be used in combination with more spatially accurate data (e.g., 1:4,800 or 1:5,000 scale data or larger). Each service type will be mapped as a unique data set comprised of arc (linear) or point features.

Data at this level are spatially more accurate in that:

1) Pipe data are represented by one of the following:

    a) Arcs taken from the Executive Office of Transportation's 1:5000 scale road network;
    b) Arcs are created from a geo-referenced CAD file where the geo-referencing is sufficiently accurate that the pipe features display in the apparent road right-of-way as viewed over the statewide 2001 color orthophotos or equivalent (except of course where the pipe is not actually in the right-of-way);
    c) Arcs created by "connecting the dots" where the dots are features on the network (e.g. manholes) whose location has been captured using a GPS receiver or compiled using photogrammetric methods

2) Point features (manholes, hydrants, catch basins, etc) may or may not be developed at this level. If they are developed, it would be from sources that are geo-referenced to produce X,Y coordinate pairs for each feature or that provide a direct X,Y coordinate (e.g., photogrammetric compilation or GPS receivers); at this level, the horizontal accuracy of the method used to create point features must produce point locations that match or improve (through geo-referencing process) on the horizontal accuracy of the source materials. If GPS receivers are used to capture these point locations, the equipment and process used must produce locations that are within +/- three meters or better of the actual location.

3) There may or may not be connections between the pipe data and the point features shown at this level. This approach accommodates situations where the pipe network may have been automated from an existing record (e.g., mylar maps or a CAD file) and the point features may have been mapped using a separate approach (e.g., with GPS receivers). While the point features are ideally adjusted to ("snapped") to a position on the pipe data of which they are a part, snapping is not required at this Level.

4) Arcs representing pipes not in a road right-of-way (e.g., pipes running cross-country in an easement or pipes located in a driveway) will be created “on-screen” as accurately as can be determined from the available information.

ATTRIBUTE REQUIREMENTS FOR PIPE DATA

Under this version of the standard, there are two possible levels of attributes that can be associated with pipe data. Level I is the least difficult to achieve and also, generally, the least useful. Level II has more extensive requirements and, therefore, is the most complex and expensive to implement. However, any community implementing Level II of the attribute portion of this standard will have a versatile and broadly useful collection of information about their pipe data that will support much more sophisticated and effective management of that infrastructure. It is entirely possible and reasonable that mapping might achieve compliance with a lower level of the compilation requirements and a higher level of the attribute requirements.

Appendix A contains a data dictionary for the attributes. A personal geodatabase template for these data sets is available on MassGIS' website at www.mass.gov/mgis/standards.htm, then go to the link for the Water, Waste Water, and Storm Water standard. A report on this geodatabase design is in Appendix B. When this standard is issued with Level III, a different version of this geodatabase design will have been developed.

Level I Attribute Requirements

All pipe features will have the following attributes:

STATUS – status of service: EX = existing, UC = under construction, PR = proposed
OWNER – Name of the owner of the pipe (e.g., city or town, private water supplier, water and/or sewer district, private packet treatment plant)
OPERATOR – System operator (e.g. water or sewer district name or contractor name). The operator may or may not be the same as the owner.
SERVICE_TYPE – WAT = water, SEW = sewer, STW = storm drain, CSO = combined sewer and storm drain.
PIPE_TYPE_CONNECT – type of service; valid values are TRANS = cross country transmission), RAW = untreated, SER = supports service connections.
GIS_DATE – date (YYYYMM format) when the feature was created in a GIS format
GIS_DEV - developer of the GIS data
SOURCE_DATE – date (YYYYMM format) when the source record was created, if known
SOURCE_DEV - developer of the source record, if known

Some of the above attributes provide feature level metadata attributes. The ISO standard for metadata that supports feature level metadata has not yet been widely adopted in the United States; therefore, these attributes have been included. Other attributes, such as a description of the source from which the file

was originally created, would be contained in an FGDC compliant metadata record. FGDC-compliant metadata is required at all levels of the standard.

Level II Attribute Requirements

All Level I attributes apply at Level II. In addition to the Level I attributes, Level II attributes for all pipe types are those described below. Note that wastewater pipes have some attributes that are not required for water and storm water pipes.

LINE_ID – unique identifier associated with a segment (node-to-node) of pipe.

DIAMETER – pipe diameter (inches). If this information is not directly available from the source information or there is insufficient funding to research this attribute, it can be estimated. The estimate could be based on knowing that most pipes in the system are a certain diameter or that pipes in particular areas are a certain diameter. The quality of the diameter information is then tracked in the *CONFIRM_DIAM* attribute.

LOCATION – whether or not pipe is in a street right-of-way; valid values are ROW (pipe in right-of-way) and CC (“cross country” pipe in an easement), and OTHER. While this information can be determined by displaying the pipe arcs in map form, having the same information as an attribute will also be useful.

CONFIRM_DIAM – whether or not (“Y”,”N”) diameter has been confirmed or is inferred from adjacent pipes or from other sources; this attribute should be updated as the information becomes available from on-going operations

OP_STATUS – operational status; valid values are ACT = active, ABND = abandoned, EMER = emergency (line only used in event of emergency; typically these lines are found as interconnections between two different water systems).

INSTALL_YEAR – year individual portions of the pipe network were constructed (format YYYY). Local knowledge and the construction year of larger subdivision plans or of entire systems might be used to populate this attribute.

CONFIRM_MATERIAL – whether or not (“Y”,”N”) material has been confirmed or is inferred from adjacent pipes or from other sources, or is unknown; this attribute should be updated as the information becomes available from on-going operations.

MATERIAL – While this attribute exists for each of the three pipe types, the domain of valid values varies. If this information is not directly available from the source information or there is insufficient funding to research this attribute, it can be presumed. Material could be presumed based on knowing that most pipes in the system or in certain regions of the system are a certain material. The quality of the material information is then tracked in the *CONFIRM_MATERIAL* field. *Material types not listed below may be used provided the codes for those additional materials are included in lookup tables supplied with the metadata.*

Water Pipe Material Domain – AC = asbestos concrete; CI = cast iron; CICL = cast iron, cement lined; DI = ductile iron; CLDI = cement lined ductile iron; TRANS = transite; PL = plastic; RJ = restrained joint; HDP = high density polyethylene; PE = polyethylene; PVC = polyvinyl chloride; UNKN = unknown.

Waste Water Pipe Material Domain – PVC = polyvinyl chloride; VC = vinyl chloride; BRK = brick; DI = ductile iron; TRAN = transite; CLDI = cement lined ductile iron; REL = relined; UNKN = unkown.

Storm Water Pipe Material Domain - RCP = reinforced concrete pipe; VCP = vitrified clay pipe; CBP = circular brick pipe; PVC = poly-vinyl chloride; DI = ductile iron pipe; CI = cast iron; ASB = asbestos concrete, UNKN = unknown.

Attributes Specific to Waste Water Pipes

DIAMETER2 – this is needed for sewer pipes, as some are rectangular or square.

MAIN_TYPE – the type of main (valid values are FOR = forced main; GRAV = gravity; and INT = interceptor.

ATTRIBUTE REQUIREMENTS FOR POINT DATA

There is no expectation of including point data at level I. At level II, various features may be included.

Level II Point Attribute Requirements

Water System Point Features

TYPE_ID - The unique identifier for each feature.
TYPE - The type of feature. Valid entries are: IN (intake), WP (water pump station), TP (filtration/treatment plant), WS (water storage tank), and MAN (manifold).

Waste Water System Point Features

MH_ID – The unique identifier within the sub-drainage basin that identifies the manhole.
TYPE – The type of node: valid values are MH (manhole), PS (pumping station), OUT (outfall), TP (treatment plant)

Storm Water System Point Features

TYPE – The type of node/point feature. Valid values are CB (catch basin), DE (ditch end), DW (dry well), IN (intake), MH (manhole), OF (outfall), LF (leaching field), and RET (retention basin).
MH_ID – A manhole's unique identifier.
DISCHARGE_ID – Unique identifier of TYPE = "OF".

APPENDIX A: DATA DICTIONARY

LEVEL I

Pipe Attributes	ATTRIBUTE	TYPE	DOMAIN/FORMAT
	STATUS	string (2)	EX = existing, UC = under construction, PR = proposed
	OWNER	string (50)	
	OPERATOR	string (50)	
	SERVICE_TYPE	string (3)	WAT = water, SEW = sewer, STW = storm drain, CSO = combined sewer and storm drain
	PIPE_TYPE_CONNECT	string (4)	TRANS = cross country transmission), RAW = untreated, SER = supports service connections
	GIS_DATE	string (6)	YYYYMM
	GIS_DEV	string (50)	
	SOURCE_DATE	string (6)	YYYYMM
	SOURCE_DEV	string (50)	

LEVEL II

Pipe Attributes			
	LINE_ID	text (12)	
	DIAMETER	short integar	Feb-80
	LOCATION	string (5)	ROW (pipe in right-of-way) and CC (“cross country” pipe in an easement), and OTHER
	CONFIRM_DIAM	string (1)	Y, N
	OP_STATUS	string (4)	ACT = active, ABND = abandoned, EMER = emergency (line only used in event of emergency
	INSTALL_YEAR	string (4)	YYYY
	CONFIRM_MATERIAL	string (1)	

	ATTRIBUTE	TYPE	DOMAIN/FORMAT
Water Pipe	MATERIAL	string (5)	AC = asbestos concrete; CI = cast iron; CICL = cast iron, cement lined; DI = ductile iron; CLDI = cement lined ductile iron; TRANS = transite; PL = plastic; RJ = restrained joint; HDP = high density polyethylene; PE = polyethylene; PVC = polyvinyl chloride; UNKN = unknown
Waste Water	MATERIAL	string (5)	PVC = polyvinyl chloride; VC = vinyl chloride; BRK = brick; DI = ductile iron; TRANS = transite; CLDI = cement lined ductile iron; REL = relined; UNKN = unkown
Storm Water	MATERIAL	string (5)	RCP = reinforced concrete pipe; VCP = vitrified clay pipe; CBP = circular brick pipe; PVC = poly-vinyl chloride; DI = ductile iron pipe; CI = cast iron; ASB = asbestos concrete, UNKN = unknown
Waste Water Pipes Only			
	DIAMETER2	short integar	10 - 80
	MAIN_TYPE	string (4)	FOR = forced main; GRAV = gravity; and INT = interceptor.
LEVEL II Point Attributes			
Water	TYPE_ID	string (12)	
	TYPE	string (3)	IN (intake), WP (water pump station), TP (filtration/treatment plant), WS (water storage tank), and MAN (manifold).
Waste Water	MH_ID	string (12)	
	TYPE	string (3)	MH (manhole), PS (pumping station), OUT (outfall), TP (treatment plant)

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	ATTRIBUTE	TYPE	DOMAIN/FORMAT
Storm Water	TYPE	string (3)	CB (catch basin), DE (ditch end), DW (dry well), IN (intake), MH (manhole), OF (outfall), LF (leaching field), and RET (retention basin).
	MH_ID	string (12)	
	DISCHARGE_ID	string (12)	

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APPENDIX B: GEODATABASE SCHEMA REPORT

A personal geodatabase template for the design below is available on MassGIS' website at www.mass.gov/mgis/standards.htm, then go to the link for the Water, Waste Water, and Storm Water standard.

Geodatabase Reporting Tool

Date Of Report **10/27/2005 3:40:59 PM**

Generated By **nmacgaffey (on ENV-WS-NMACGAF3)**

Geodatabase Type **Personal [Version 2.0.1 (Current Release)]**

Database **V:\MgisProjRes\Projects\standards\WaterSewerGDB\PipeInfrastructure.mdb**

Geodatabase Report Contents

Geodatabase Summary

FeatureDataset	Object Name (Alias)	Type	Geometry	Subtypes
None	Wastewater_Pipes (Wastewater pipes) (S) (C)	Simple Feature	Polyline	None
	Wastewater_Points (Wastewater Points) (S) (C)	Simple Feature	Point	None
	Water_Pipes (Water Pipes) (S) (C)	Simple Feature	Polygon	None
	Water_Points (Water Points) (S) (C)	Simple Feature	Point	None
	CONFIRM_DIAM	Domain	Coded Value	
	CONFIRM_MAT	Domain	Coded Value	
	LOCATION	Domain	Coded Value	
	MAIN_TYPE	Domain	Coded Value	
	OP_STATUS	Domain	Coded Value	
	PIPE_TYPE_CONNECT	Domain	Coded Value	
	SERVICE_TYPE	Domain	Coded Value	
	STATUS	Domain	Coded Value	
	WASTEWATER_MATERIAL	Domain	Coded Value	
	WASTEWATER_TYPE	Domain	Coded Value	
	WATER_MATERIAL	Domain	Coded Value	
	WATER_TYPE	Domain	Coded Value	

ObjectClass Information

Wastewater_Pipes (Simple Feature) (Polyline)

No Subtypes

Field Name	Field Type	Pre	Sc	Len	DV	Domain
OBJECTID	OID	0	0	4		
SHAPE	Geometry	0	0	0		
STATUS	String	0	0	2		STATUS
OWNER	String	0	0	50		
OPERATOR	String	0	0	50		
SERVICE_TYPE	String	0	0	3		SERVICE_TYPE
PIPE_TYPE_CONNECT	String	0	0	4		PIPE_TYPE_CONNECT
GIS_DATE	String	0	0	6		
GIS_DEV	String	0	0	50		
SOURCE_DATE	String	0	0	6		
SOURCE_DEV	String	0	0	50		
LINE_ID	String	0	0	12		
DIAMETER	Small Integer	0	0	2		
DIAMETER2	Small Integer	0	0	2		
LOCATION	String	0	0	5		LOCATION
CONFIRM_DIAM	String	0	0	1		CONFIRM_DIAM
OP_STATUS	String	0	0	4		OP_STATUS
INSTALL_YEAR	String	0	0	4		
CONFIRM_MATERIAL	String	0	0	1		CONFIRM_MAT
MATERIAL	String	0	0	5		WASTEWATER_MATERIAL
MAIN_TYPE	String	0	0	4		MAIN_TYPE
SHAPE_Length	Double	0	0	8		

Wastewater_Points (Simple Feature) (Point)

No Subtypes

Field Name	Field Type	Pre	Sc	Len	DV	Domain
OBJECTID	OID	0	0	4		
SHAPE	Geometry	0	0	0		
MH_ID	String	0	0	12		
TYPE	String	0	0	3		WASTEWATER_TYPE

Water_Pipes (Simple Feature) (Polygon)

No Subtypes

Field Name	Field Type	Pre	Sc	Len	DV	Domain
OBJECTID	OID	0	0	4		
SHAPE	Geometry	0	0	0		
STATUS	String	0	0	2		STATUS
OWNER	String	0	0	50		
OPERATOR	String	0	0	50		
SERVICE_TYPE	String	0	0	3		SERVICE_TYPE
PIPE_TYPE_CONNECT	String	0	0	4		PIPE_TYPE_CONNECT
GIS_DATE	String	0	0	6		
GIS_DEV	String	0	0	50		
SOURCE_DATE	String	0	0	6		
SOURCE_DEV	String	0	0	50		
LINE_ID	String	0	0	12		
DIAMETER	Small Integer	0	0	2		
LOCATION	String	0	0	5		LOCATION
CONFIRM_DIAM	String	0	0	1		CONFIRM_DIAM
OP_STATUS	String	0	0	4		OP_STATUS
INSTALL_YEAR	String	0	0	4		

CONFIRM_MATERIAL	String	0	0	1		CONFIRM_MAT
MATERIAL	String	0	0	5		WATER_MATERIAL
SHAPE_Length	Double	0	0	8		
SHAPE_Area	Double	0	0	8		

Water_Points (Simple Feature) (Point)

No Subtypes

Field Name	Field Type	Pre	Sc	Len	DV	Domain
OBJECTID	OID	0	0	4		
SHAPE	Geometry	0	0	0		
TYPE_ID	String	0	0	12		
TYPE	String	0	0	3		WATER_TYPE

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Domain Information

CONFIRM_DIAM

Field Type	String	Merge Policy	Default Value
Domain Type	Coded Value	Split policy	Default Value

Value	Description
Y	Pipe diameter confirmed
N	Pipe diameter not confirmed

Domain Assigned To

ObjectClass Type	ObjectClass Name	Subtype	Field
FeatureClass	Wastewater_Pipes	None	CONFIRM_DIAM
FeatureClass	Water_Pipes	None	CONFIRM_DIAM

CONFIRM_MAT

Field Type	String	Merge Policy	Default Value
Domain Type	Coded Value	Split policy	Default Value

Value	Description
Y	Pipe material confirmed
N	Pipe material not confirmed

Domain Assigned To

ObjectClass Type	ObjectClass Name	Subtype	Field
FeatureClass	Wastewater_Pipes	None	CONFIRM_MATERIAL
FeatureClass	Water_Pipes	None	CONFIRM_MATERIAL

LOCATION

Field Type	String	Merge Policy	Default Value
Domain Type	Coded Value	Split policy	Default Value

Value	Description
ROW	Pipe in right-of-way
CC	Pipe in easement
OTHER	Other location

Domain Assigned To

ObjectClass Type	ObjectClass Name	Subtype	Field

FeatureClass	Wastewater_Pipes	None	LOCATION
FeatureClass	Water_Pipes	None	LOCATION

MAIN_TYPE

Field Type	String	Merge Policy	Default Value
Domain Type	Coded Value	Split policy	Default Value

Value	Description
FOR	Forced
GRAV	Gravity
INT	Interceptor

Domain Assigned To

ObjectClass Type	ObjectClass Name	Subtype	Field
FeatureClass	Wastewater_Pipes	None	MAIN_TYPE

OP_STATUS

Field Type	String	Merge Policy	Default Value
Domain Type	Coded Value	Split policy	Default Value

Value	Description
ACT	Active
ABND	Abandoned
EMER	Active in emergency only

Domain Assigned To

ObjectClass Type	ObjectClass Name	Subtype	Field
FeatureClass	Wastewater_Pipes	None	OP_STATUS
FeatureClass	Water_Pipes	None	OP_STATUS

PIPE_TYPE_CONNECT

Field Type	String	Merge Policy	Default Value
Domain Type	Coded Value	Split policy	Default Value

Value	Description
RAW	Untreated
SER	Supports service connections
TRAN	Cross country transmission

Domain Assigned To

ObjectClass Type	ObjectClass Name	Subtype	Field
FeatureClass	Wastewater_Pipes	None	PIPE_TYPE_CONNECT
FeatureClass	Water_Pipes	None	PIPE_TYPE_CONNECT

SERVICE_TYPE

Field Type	String	Merge Policy	Default Value
Domain Type	Coded Value	Split policy	Default Value

Value	Description
WAT	Water
SEW	Sewer
STW	Stormwater
CSO	Combined Sewer/Storm

Domain Assigned To

ObjectClass Type	ObjectClass Name	Subtype	Field
FeatureClass	Wastewater_Pipes	None	SERVICE_TYPE
FeatureClass	Water_Pipes	None	SERVICE_TYPE

STATUS

Field Type	String	Merge Policy	Default Value
Domain Type	Coded Value	Split policy	Default Value

Value	Description
EX	Existing
UC	Under construction
PR	Proposed

Domain Assigned To

ObjectClass Type	ObjectClass Name	Subtype	Field
FeatureClass	Wastewater_Pipes	None	STATUS
FeatureClass	Water_Pipes	None	STATUS

WASTEWATER_MATERIAL

Field Type	String	Merge Policy	Default Value
Domain Type	Coded Value	Split policy	Default Value

Value	Description
PVC	Polyvinyl chloride
VC	Vinyl chlorid
BRK	Brick
DI	Ductile iron
TRANS	Transite
CLDI	Cement lined ductile iron
REL	Relined
UNKN	Unknown

Domain Assigned To

ObjectClass Type	ObjectClass Name	Subtype	Field
FeatureClass	Wastewater_Pipes	None	MATERIAL

WASTEWATER_TYPE

Field Type	String	Merge Policy	Default Value
Domain Type	Coded Value	Split policy	Default Value

Value	Description
MH	Manhole
PS	Pumping station
OUT	Outfall
TP	Treatment plant

Domain Assigned To

ObjectClass Type	ObjectClass Name	Subtype	Field
FeatureClass	Wastewater_Points	None	TYPE

WATER_MATERIAL

Field Type	String	Merge Policy	Default Value
Domain Type	Coded Value	Split policy	Default Value

Value	Description
AC	Asbestos concrete
CI	Cast iron
CICL	Cast iron concrete lined
CLDI	Cement lined ductile iron
TRANS	Transite
PL	Plastic
RJ	Restrained joint
HDP	High density polyethylene
PE	Polyethylene
PVC	Polyvinyl chloride
UNKN	Unknown

Domain Assigned To

ObjectClass Type	ObjectClass Name	Subtype	Field
FeatureClass	Water_Pipes	None	MATERIAL

WATER_TYPE

Field Type	String	Merge Policy	Default Value
Domain Type	Coded Value	Split policy	Default Value

Value	Description
IN	Intake
WP	Water pump
TP	Filtration/Treatment
WS	Water storage tank
MAN	Manifold

Domain Assigned To

ObjectClass Type	ObjectClass Name	Subtype	Field
FeatureClass	Water_Points	None	TYPE

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APPENDIX C: PARTICIPANTS IN STANDARD DEVELOPMENT

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